EMISSIONS INVENTORY

32) TITLE: Assessment of Out-of-State Heavy-Duty Truck Activity Trends in California

PROBLEM: An increasing number of out-of-state heavy-duty trucks are operating in California each year. However, some data suggest that the average number of miles driven by each truck is decreasing. In addition, while some of these trucks appear to be transitory in nature, it appears that some trucks may be domiciled within California even though they are not registered within the state. As emissions from mobile sources become a larger portion of overall emission inventory, information is needed to accurately determine the impacts of these vehicles.

PREVIOUS WORK: Limited data is available on the activity trends of out-of-state trucks in California. In California, the Department of Transportation has collected some limited information on heavy-duty truck activity, and the Department of Motor Vehicles received some limited data on the number of out-of-state trucks entering California each year.

OBJECTIVE: The objective is to provide information necessary for staff to evaluate the emission impacts of out-of-state heavy-duty trucks on the California inventory. The information will allow staff to develop and/or coordinate programs that may reduce emissions from these vehicles.

DESCRIPTION: Under the proposed project, data would be collected on out-of-state heavy-duty trucks to determine.

- fueling patterns;
- quality of the fuel used;
- vehicle miles traveled, and
- amount of time spent in California.

BENEFITS: This project will benefit the citizens of the state by identifying the impacts out-of-state heavy-duty trucks have on California emissions, and allow for the development of potential control measures. These measures can reduce the impacts of both criteria pollutants as well as diesel particulate emissions.

33) TITLE: Determine the Population Mix of Off-Road Equipment by Applications and End Users; such as Agriculture, Warehousing, Automotive, Construction Etc.

PROBLEM: Our understanding of the contributions of various off-road mobile emission sources is critically dependent on knowing how much of the various equipment types are in service, and how much (and when) they are being used. Recent studies have updated this information for residential small off-road engines. Unfortunately, the information gathered in these studies did not examine the question of whether some of these equipment types are properly categorized with respect to federal preemption, which exempts farm and construction equipment under 175 horsepower from California new engine control programs. The data supporting previous preemption decisions are now over 10 years old, and should be updated.

We do not expect the study to have any impact on obviously preempt equipment like tractors, harvesters, graders, and loaders. However, it could impact (for example) equipment like compressors and aerial lifts, if it showed their use to be predominantly in nonpreempt applications. Note that before any change to the preemption lists would be made based on this study, it would be subject to extensive stakeholder review, paying particular attention to experts in the impacted industry.

PREVIOUS WORK: A list of farm and construction equipment was developed jointly by ARB and industry in the mid-1990's. It was developed with the limited data available at the time. A separate study funded by a natural gas association in the 1990's estimated the uses of forklifts by applications/end users.

OBJECTIVE: To identify off-road equipment population by applications and end users.

DESCRIPTION: Update the list of all the equipment types with off-road engines under 175 horsepower. Determine the population of each equipment type by application/end user.

BENEFITS: An updated list of all the equipment types of off-road engines under 175 horsepower would help clarify and provide a better understanding of the impact of preempt engines on California's emission inventory and provide a basis for dialogue with stakeholders on any changes needed.

34) TITLE: Incidence and Severity of Component Malfunction and Tampering for In-use Heavy-duty Diesel Vehicles

ABSTRACT

Emissions from on-road heavy-duty diesel (HDD) vehicles represent a disproportionate source of oxides of nitrogen (NOx) and particulate matter (PM). Malfunctions and tampering are important causes of elevated emissions and the incidence rates for nineteen categories are listed in the EMFAC 2000 model. However, the estimates for the incidence rates vary by more than 100% depending on the source of the estimate. In addition, the data are old and incomplete. This report details the work conducted under Phase I of this project, which was to compare the existing factors for tampering and malfunctioning for HDD trucks in the EMFAC model with those arrived at by the use of several new and independent methods and review of about 7,000 HDD truck records.

The approach or design of the new methods followed the life cycle and repair records of a HDD truck. For about 25% or 290,000 miles of its life cycle, the trucks are covered by a warranty and records are kept at ARB and EPA for specific causes of high emissions. From the analysis of 998 warranty incidents, we learned that most malfunctioning rates were in fair agreement with the values in EMFAC, except that the incidence rates of problems were much higher for fuel injectors, turbos and electronics. Being in fair agreement or higher gives cause for concern as the rates in EMFAC reflect the full life cycle and are expected to be low for the first 25% and increase dramatically for the last 25%. These data suggested that EMFAC may be underestimating the contributions from malfunctions. However, the driver survey and independent repair shop survey data, both of which are instantaneous measures of tampering and malfunction, correspond well with the EMFAC data.

Other data sources proved helpful in providing new insight on the remaining 75% of its engine life. For example, the analysis of 5,210 records for trucks that were inspected indicated that tampering was <1%, so tampering is either not visible or is not there to begin with. Based on our observations when working along side the ARB experienced inspectors in the field and as most engines are designed with electronic controls, we do not think that tampering is a major contributor to emissions and, therefore, conclude that dedicating time to enhanced visual inspections would not be fruitful. However, our pilot work of electronic monitoring was the first to be undertaken in the field and the results yielded new insight about what information was available with proprietary download tools and how it could be analyzed, especially the issue of whether a off-cycle NOx chip was installed. Electronic monitoring should be pursued, as knowing if a reflashed chip is installed will become very important as the vehicles are modified to meet the new low-NOx standards.
A random roadside survey of 78 drivers about the problems with their trucks was undertaken with the resulting malfunction rates again in fair agreement with the values in the EMFAC table. The questionnaire for this form of a data collection is very important so that key information is obtained in an unambiguous nature in a short period of time. We suggest obtaining more surveys even thought the data is probably of a lower quality.

Link to full report: ftp://ftp.arb.ca.gov/carbis/research/apr/past/01-340.pdf

35) TITLE: Improvement of Emissions Inventory for Stationary and Portable Engines

ABSTRACT

This study has developed test methods and protocols for determining compliance with emission standards for stationary and portable engines as promulgated by either the California Air Resources Board (CARB) or the U.S. Environmental Protection Agency (EPA). This study has resulted in a simple, cost-effective, yet accurate test method for stationary and portable engines to measure in-use emissions to ensure attainment of emission reduction goals. Additionally, the method will allow determination of compliance with the emission limits established by the Statewide Portable Equipment Registration Program. The method will allow measurement of fuel-specific emissions from both, diesel- and gasoline-fueled portable and stationary engines under real-world conditions. Given the fact that most stationary and portable engines are mechanically controlled engines, measurement of engine speed and load in the field would be not be a viable option, due to the associated complexity of such measurements. Hence, a “Compliance Factor” approach, based upon CO2-specific or fuel-specific emissions-measurements, has been developed and presented to CARB in this report. This method requires measurement of concentration of gaseous pollutants and the mass of particulate matter (PM) emissions. Errors introduced by the measurement of engine load and exhaust flow rate in determining brake-specific emissions are avoided. The Compliance Factor is a ratio of NOx and CO2 concentrations (In-field ratio, I) to the brake-specific mass emissions of NOx and CO2 (Certification ratio, C). The Certification ratio, C, is obtained either from the manufacturer, or from laboratory evaluation of the test engine on an ISO 8178 cycle. The test method presented to CARB was validated by running an extensive series of steady-state 8-mode tests (ISO 8178 cycle) that were conducted on both, mechanically and electronically controlled engines. It was also determined that the front-half of the Method 5 PM measurement methodology is in good agreement with the CVS system based engine certification PM test method. Further, a modified Method 5 sampling train comprising of a multi-hole sampling

probe that spans the diameter of the exhaust stack, and a sample transfer tube maintained at ambient temperature could be a likely configuration for measuring PM from stationary and portable diesel engines in the filed. This approach does away with the cumbersome method of modifying the small diameter (2 inches to 6 inches for most applications) exhaust stacks of diesel engines, and traversing the exhaust stack to acquire samples at 8 locations along the stack diameter. WVU has been involved with in-use, in-field measurements from heavy-duty vehicles for a decade using its transportable chassis dynamometer based emissions measurement laboratories. Today, evaluation of in-use, "real world" emissions from on-highway heavy-duty vehicles is gaining momentum due, in part, to the availability of transportable heavy-duty chassis dynamometer facilities developed by WVU, and the new in-use, on-board Mobile Emissions Measurement System (MEMS). Similar advances are essential for stationary and portable engines. However, it should be noted that measurement of in-use mass emission rates from on-highway vehicles is still an issue, and this is due to a lack of a "suitable" chassis test cycle that could be employed for all heavy duty vehicles (buses, trucks with automatic transmissions, as well as those with unsynchronized transmissions and low power-to-weight ratios). This problem of a lack of a single test cycle for the entire body of vehicles is dwarfed by the absence of any test cycle for "real world" testing of stationary and portable equipment and engines. Development of test methods for in-use compliance of stationary and portable engines is now imperative in light of the urgent need to attain emission reduction goals, and develop inspection and maintenance (I/M) programs. The process of development and implementation of the test method presented to CARB for stationary and portable engines tapped into WVU's experiences and "lessons learned" from the on-highway vehicle in-use emissions measurement exercises. Recommendations have been made on the most suitable measurement tools for in-use emissions measurements, and Standard Operating Procedures (SOP) for conducting a in-field tests are also presented. WVU has recommended use of exhaust emission analyzers that can accurately and precisely measure gaseous concentrations, and a micro-dilution tunnel for filter-based gravimetric PM emissions measurements. This approach will reduce the cost of portable analyzer equipment by tens of thousands of dollars compared to the currently available commercial portable emissions measurement systems.

Link to full report: ftp://ftp.arb.ca.gov/carbis/research/apr/past/00-06.pdf

36) TITLE: Analysis of Particulate Matter from Tire and Brake Wear of On-Road Vehicles

PROBLEM: Up to one-third of all directly emitted particulate matter from on-road motor vehicles has been attributed to either tire or brake wear; however, these emission estimates have not been updated in over a decade. New materials used in brake linings and the elimination of bias ply tires may have significantly reduced total emissions of particulate matter from these sources. The information regarding tire and brake wear for PM2.5 emissions is in need of revision, and is poorly documented. Emission factors for PM2.5 are currently not available for both brake wear and tire wear. Since PM2.5 goes deeper into the lungs and there is now a Federal PM2.5 ambient air quality standard, it is necessary to determine PM2.5 emissions from tire and brake wear.

PREVIOUS WORK: Previous analyses have been performed on a limited number of vehicles, yielding four emission rates for tire wear based on vehicle type (autos, light trucks, medium

trucks, and heavy trucks) and a single gram-per-mile emission rate for brake wear. Emission rates are probably affected by differences in brake and tire materials and by driving patterns. However, the most current data available, taken from the U.S. EPA's PART 5 particulate matter model, still lists a single value for brake wear.

OBJECTIVE: To determine the gram-per-mile particle emission rate from tire and brake wear, the particle size distribution in these emissions, and the influence that different driving patterns may have on particulate emissions.

DESCRIPTION: A number of vehicles would be tested with various tire and brake configurations in an evaporative emissions running loss enclosure adapted to sample ambient concentrations of particulate. These vehicles would be operated over two or more driving cycles to determine the effect of driving patterns on particulate emissions. Measurements of PM10 and 2.5 would be performed, the emissions would be chemically analyzed, and the relative contributions of tire and brake wear to the emissions inventory would be determined.

BENEFITS: Greater emphasis is now being placed on the health effects of exposure to particulate matter. This study would provide the information necessary to correctly identify the sources and to update the on-road emissions inventory.